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HIGH-ALTITUDE FLYING IN RELATION TO EXPLORATION

By HENRY WOODHOUSE

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There is no phase of aëronautical development that appeals to the geographer more keenly than the prospective use of the airplane in the exploration and mapping of the still unknown or little-known regions of the earth. In most cases the problem of such exploration involves the covering of areas of relatively great horizontal extent, requiring long-distance flights at low altitudes. A different type of problem, however, is encountered in the exploration of lofty mountain ranges, where high-altitude flying is involved. It is here proposed to discuss the vertical range of airplane flights in relation to this second type of exploration.

The trail of the airplane has already been carried over several of the world's famous ranges—over the Alps and the Andes; and new roads of conquest have been made in an interesting series of flights across the classic and forbidden ground of the Atlas. Last year three French aviators under the direction of Commandant Cheutin, Director of the French Air Service in Morocco, using Voisin bombing biplanes flew from Meknes to Bou Denib, crossing both the Middle Atlas and the High Atlas. The following day three small Nieuport pursuit-type biplanes made the return flight from Bou Denib to Meknes. One of the aviators continued on to Rabat. It was a flight of about 260 miles each way at heights of about 15,000 feet, because parts of the High Atlas are from 12,000 to 14,000 feet high. It was made successfully in a little over three hours. Previously Lieutenant Vasseur had crossed the High Atlas from Agadir and Marra-kech. The mountain flying that has already been accomplished encourages aviator and geographer to look towards the conquest of the loftiest and least attainable of the world's ranges—the Himalaya.¹

HIGH-ALTITUDE VERSUS LONG-DISTANCE FLIGHTS

Certain remarkable developments that have taken place in aëronautic art and science in the past six months make the problem of crossing the Himalaya seem easier to solve than the problems of certain proposed long-distance flights. It appears easier than the problems connected with the proposed transatlantic flights—which include seven different plans²—or those connected with the projects of Rear Admiral Robert E. Peary and

¹ For a suggestive paper bearing on the topic see A. M. Kellas: The Possibility of Aerial Reconnaissance in the Himalaya, *Geogr. Journ.*, Vol. 51, 1918, pp. 374-389.

² See a number of articles in *Flying*, Vol. 7, 1918-19, pp. 508-521, especially p. 521.

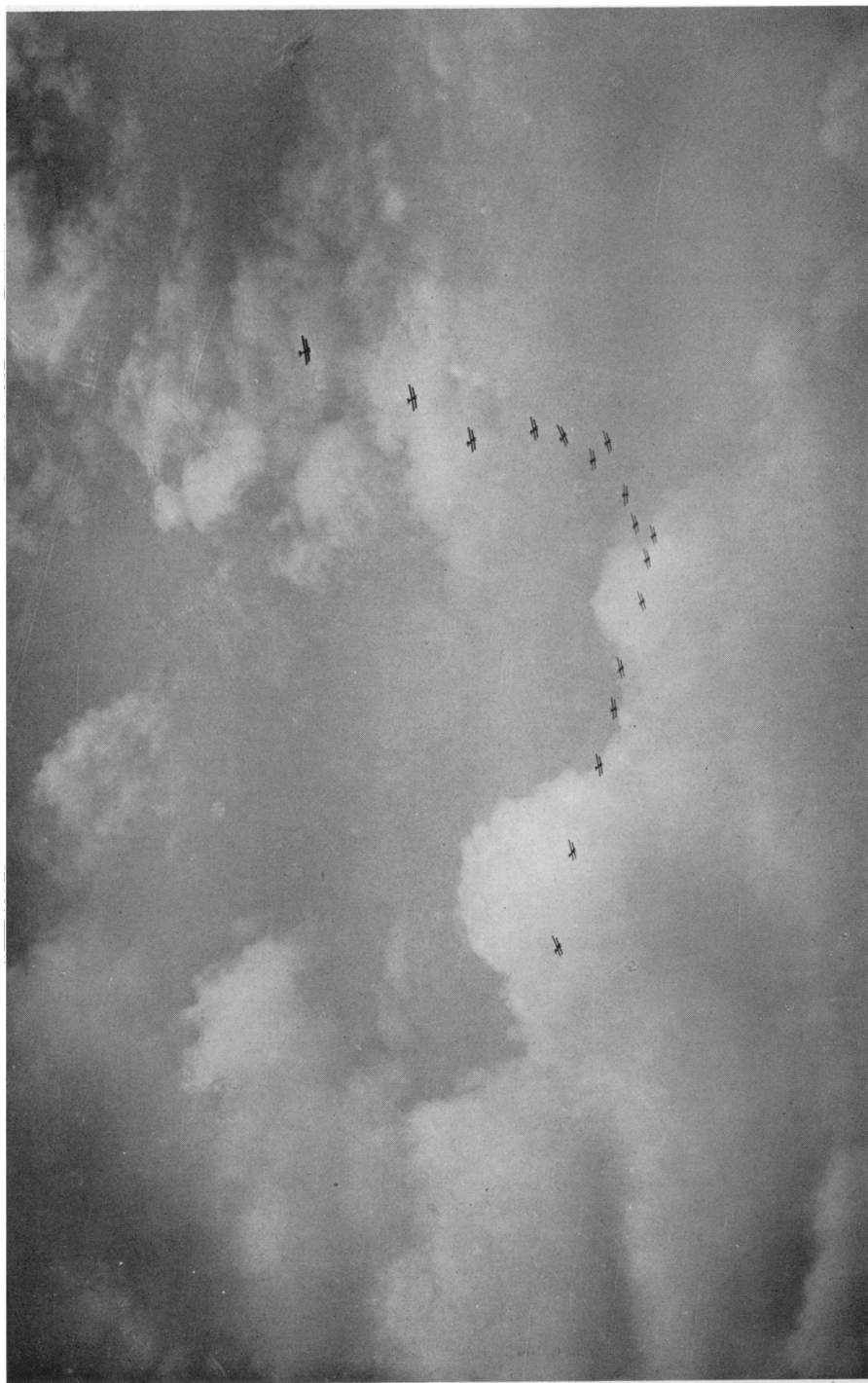


FIG. 1—Airplanes flying in battle formation, Rockwell Field, San Diego, Cal. The birdlike quality of the airplane is vividly brought out in this photograph. (Copyright by the Committee on Public Information.)

Captain Robert A. Bartlett, which provide for flights from Cape Aldrich to the North Pole and back, and from Cape Aldrich to Cape Chelyuskin, on the Siberian side.

In crossing and flying over the Himalaya there is really only one cardinal factor to be considered—*great altitude*. In Arctic exploration and transatlantic flight we have three other requirements to be met:

- (1) A sustained flight, twice as long as the longest yet made.
- (2) From ten to twenty-five hours continuous service of the pilots on the airplane.

(3) The use of instruments for determining the course when astronomical observations, "shooting" the horizon, and ascertaining the airplane's speed and drift are, to put it mildly, difficult.

Furthermore great altitude has had to be considered as a factor in making plans for Arctic or transatlantic flight because the present-day airplane is just large enough to carry the load necessary to make a continuous flight from St. Johns, Newfoundland, to Ireland, without much margin and there may, therefore, be an advantage in flying at altitudes of from 15,000 to 25,000 feet in order to gain the increase of speed afforded through the help of the winds prevailing at those altitudes.

FLYING OVER THE HIMALAYA

The problem of flying over the Himalaya resolves itself into three parts:

(1) Crossing the mountains by flying through the passes or gorges or by passage over the main range and avoidance of the high peaks.

(2) Flying over the highest peaks, including Mt. Everest, which is 29,002 feet, and Mt. Kangchenjau, which is almost as high.

(3) Making a landing on the ranges.

According to Dr. Kellas the main range could be crossed at an altitude of 23,000 to 25,000 feet by avoiding the peaks that are over 24,000 feet high, of which, so far as is known, there are about eighty. Further, by utilizing passes or gorges transit could be made at a still lower elevation—not over 19,000 feet. These altitudes can be reached by present-day airplanes. There are a great many airplanes used by the British and the other Allied nations that have a "ceiling" (maximum altitude attainable by the plane) of approximately 30,000 feet with the usual military load; and the flight across the Himalaya through the gorges and passes would not be considered more difficult than the flights made daily over the enemy's barrage fire, where in addition every cloud may hide a squadron of enemy fighting planes. It certainly would not be as difficult as was the flight of the squadron of Italian S. V. A. single-motored biplanes that, under the command of Major Gabriele d'Annunzio on August 10, 1918, flew from Venice to Vienna, a trip which involved more than two hours' flying over the Alps. In regard to the altitudes attainable by airplanes in present use we have certain recently established records.

RECORD ALTITUDES REACHED BY AIRPLANE

On August 12, 1918, Captain (now Major) R. W. Schroeder made a record flight of 26,850 feet at the Wilbur Wright Field, Dayton, Ohio. A few weeks later he established a new record, going up to 28,900 feet (corrected altitude), only a hundred feet less than the height of Mt. Everest. Major Schroeder has described his experiences.³ The flight was the culmination of a series of experiments and of continuous experience in high-altitude flying. "I had been to 12,000 feet at different times and

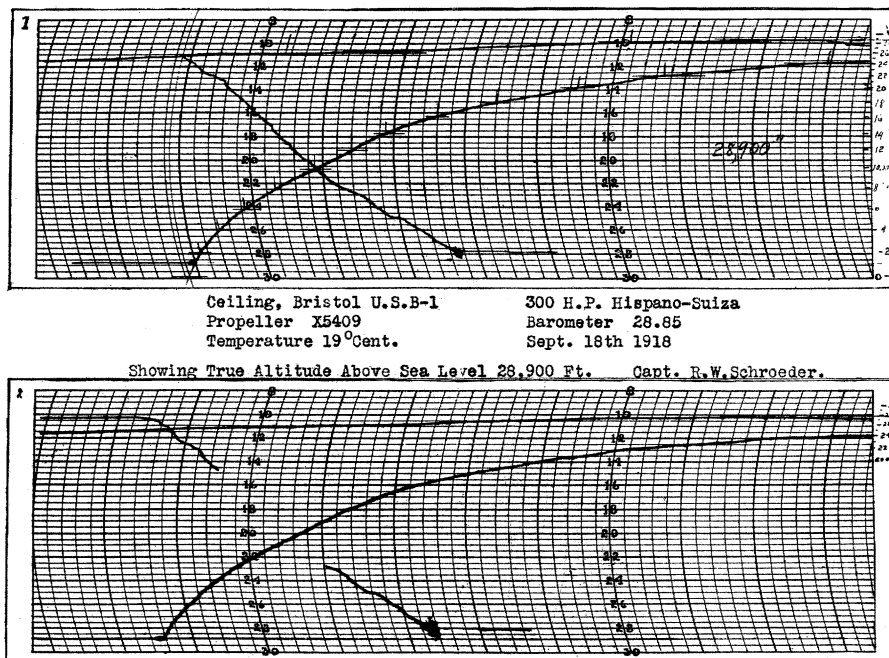


FIG. 2—Barograph curves of Major Schroeder's record flight of 28,900 feet on September 18, 1918. The scale of feet is on the right. Both barographs were calibrated by the Bureau of Standards and also calibrated in the McCook Field laboratories just before the flight.

experienced no difficulties," says Major Schroeder. "After being put in charge of the Testing Squadron at Wilbur Wright Field, my duties required me to go to the ceiling with all new types of high-powered battle aëroplanes, which were being experimented with by the United States Government. . . . During these trips I would quite often go without the use of oxygen, and in time I discovered that I was becoming accustomed to the rare, thin air. However, I did not seem to be able to go above 23,000 feet at any time without feeling a sort of sleepy, tired, cross, and hungry feeling, which I was unable to overcome except by the use of oxygen." This would seem to be a confirmation of the suggestion put forward by

³ See R. W. Schroeder: How I Made the Altitude Record of 28,900 Feet, *Flying*, Vol. 7, 1918-19, pp. 906-907.

Dr. Kellas, "It is quite possible that by repeated trial flights from sea level to 22,000 to 25,000 feet, using oxygen only when absolutely necessary, the alveolar epithelium might be educated to make the most of a minimum supply of oxygen."⁴

Respecting his record flight Major Schroeder reports that at 27,000 feet he began to suffer from the cold, raw air; but he kept on climbing until his oxygen supply began to give out, and shortly afterward the motor stopped for lack of gasoline. At the maximum height the thermometer registered

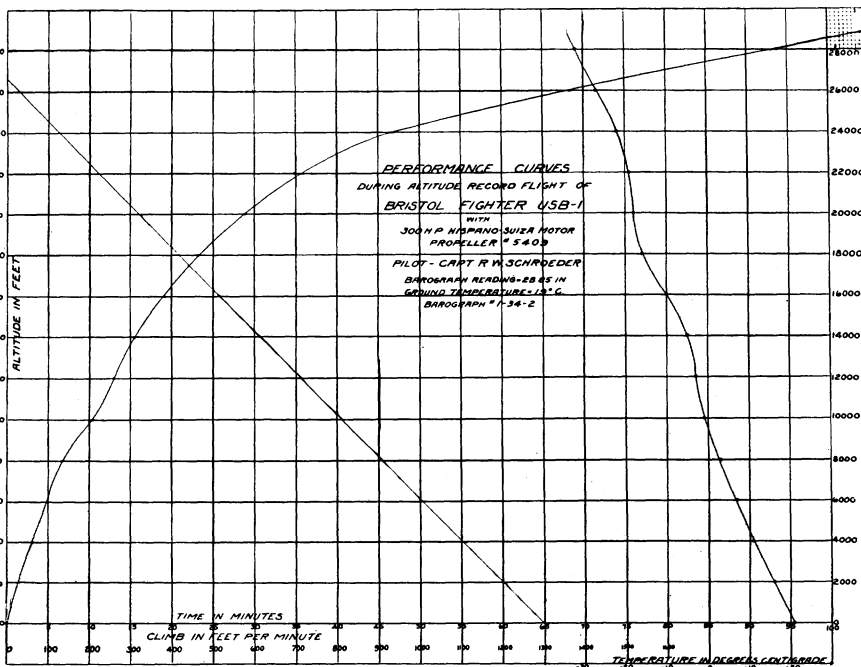


FIG. 3—Performance curve of Major Schroeder's record flight. To the right is also shown the curve of temperatures. At the highest altitude the temperature of $-32^{\circ}\text{C}.$ was recorded.

$-32^{\circ}\text{C}.$ Hands and face became numb, and on descent lips and fingers were found to be frozen and in need of medical attention. Major Schroeder, however, expressed the opinion that with a few changes and improvements in equipment he should be able to get up to 30,000 feet or more.

On January 2 of this year Major Schroeder's record was broken at Ipswich, England, by a British aviator, Captain Andrew Lang, who climbed to 30,500 feet. Captain Lang's observer fainted through lack of oxygen, his supply pipe having been broken by the vibration, and on descending both observer and pilot were suffering from frostbite. Commenting on the performance, *Nature* remarks: "the height attained was limited by the failure of petrol-pump pressure, due to the rarity of the air, and not by the

⁴ Article cited in footnote 1, p. 380.

aërodynamic performance of the machine" "It would appear, however, that even greater heights could be reached if minor difficulties, such as those connected with carburation at low temperatures and the maintenance of the pilot's comfort, were overcome."⁵

THE MECHANICAL PROBLEM OF FLYING OVER THE HIGHEST PEAKS

To carry out the project of flying over Mt. Everest and Mt. Kangchen-jhau it will be necessary to build special airplanes. It is of little value from a military viewpoint to have a plane with a ceiling of 35,000 feet unless it can carry guns and munitions and the pilot can patrol for about two hours. In addition, the machine must have a maximum equipment of safety to



FIG. 4—Russian aviators starting for flights in mid-winter. The airplanes on the right are equipped with skids for snow-landing instead of with wheels, as in the usual type on the left.

enable the pilot to make vertical turns, to do the "roll," the "falling leaf," the "Immermann turn," the "nose dive," the "loop," and other similar maneuvers that may be necessary in the course of an aerial flight; the machine must also have a very high horse-power motor to insure maximum speed.

The explorer can dispense with machine guns and ammunition, although he should carry a gun for protection in case he lands away from his starting point. He can also dispense with one hour's fuel, and the construction of the machine can be lighter. But these two considerations should come last. The greatest saving in weight will be in having a smaller motor—and correspondingly less fuel and tankage.

FLYING AT LOW TEMPERATURES

The writer has followed closely the progress made towards the solution of the problems of winter flying since 1914, when he was asked by the

⁵ *Nature*, No. 2567, Vol. 102, 1919, Jan. 9, p. 369.

friends of Vilhjálmur Stefánsson whether it would be possible to use airplanes in connection with a proposed relief expedition. The plan looked difficult at the time, but, considering the stakes involved, the chances of success seemed sufficient to justify the undertaking. It was, however, a plan which could be carried into effect only during the six or eight weeks of summer weather. The airplanes could be got together, but the rest of the expedition could not be organized in time; therefore the plan had to be given up. But the project for aviation in the Arctic did not end there.



FIG. 5—The High Atlas photographed from one of the French military airplanes that flew over the range. The higher crests are visible in the extreme background.

In 1916 Admiral Peary opened another opportunity for the writer to study the subject in connection with Captain Robert A. Bartlett's project to fly from Cape Aldrich to Cape Chelyuskin. Captain Bartlett's plan would have been carried out in 1917 had not the war prevented. Today the vision of these two hardy American explorers seems to be well on the way towards materialization. The Aero Club of America plans to send out an aerial polar expedition under Captain Bartlett in June, 1919.⁶ The experiences of its members will contribute not only to the solution of the immediate problem but also to our general knowledge of flying in relation to snow and ice surfaces—knowledge that may well prove helpful on the Himalaya.

A great deal of flying in cold weather and over snow surfaces was done on the different battle fronts in the winter of 1917-1918, as well as at the aviation schools in Canada and the United States, and considerable data

⁶ See: Captain Bartlett's Arctic Expedition, *Flying*, Vol. 7, 1918-19, pp. 1148-1149.

and photographs were collected at the time. The writer also had occasion to question Russian aviators regarding their experiences in flying in Russia during the winter of 1917-1918, under conditions which were probably more severe than aviators would meet in flying over the Himalaya ranges. They were obliged to fly daily for months and to face German anti-aircraft guns and German airplanes. All observations go to show that the solution of the problem of flying in cold weather consists largely in providing suitable clothing for the aviator. Furthermore the airplane can itself be equipped to give a certain protection. The military aviator cannot be enclosed in a cabin, to be sure, but the explorer can be protected by a hood of transparent material. The sides and bottom of the plane can also be constructed of transparent material, which will give him a clear and wide view and permit him to see everything about him as he flies.

PHYSIOLOGICAL EFFECTS OF HIGH ALTITUDES

At high altitudes the effect of the rarefaction of the air is more important than the influence of the low temperature. The effect on aviators of flying at high altitudes is a matter about which there are as yet no exact data. Ever since aviators began to fly above the 2,000-foot mark we have been hearing of possible physiological effects. Only a very small percentage of aviators complain of physiological difficulties. The proportion is probably not larger than is to be found in practically every other line of human activity.

The effect of mountain climbing is not a good criterion from which to judge the effect of high flying, just as the sensation of looking down from a high building is no criterion from which to judge the sensation of looking down from an airplane while flying. The aviator has this advantage over the mountain climber, that he can start out in perfect physical condition and can accomplish the entire journey in a few hours, whereas it would take the mountain climber days or weeks. Reports carefully kept by the writer of the experience of aviators and balloonists who have made altitude records show that flying at high altitudes is by no means as difficult as it is thought to be.

History has recorded several deaths as attributable to rising to high altitudes without a proper supply of oxygen. Whether history is right or not, remains for the future to prove. H. F. Sivel and J. E. Crocé-Spinelli met their death in April, 1878, in ascending to 28,200 feet in a balloon; and the Germans, Arthur Berson and R. J. Süring, who reached an altitude of 35,000 feet (accepted as the record) in 1901, descended in rather bad condition. These cases were attributed to altitude sickness (hypsozemia); but the writer is led to believe from his own experience that those pioneers may have been victims of asphyxiation, owing to their rising so fast that they were suffocated by gas escaping from their balloon. Another remarkable balloon ascent was made in May, 1913, by three Frenchmen,

Jacques Schneider, Maurice Bienaimé, and Albert Senouique. M. Schneider reported the experiences of his party in *Flying* for January, 1914.

At 2.35 we attained the 7,000 meters altitude. The view below was less clear; a thick layer of cirrus enveloped us and moved slowly like shifting mountains of light wadding. At 3.00 o'clock we reached 8,000 meters and we met snow which troubled somewhat our progress in altitude. At 3.15 we had reached a height of 9,000 meters and at 3.32 Mr. Bienaimé, who had taken his turn in service, emptied the 109th bag

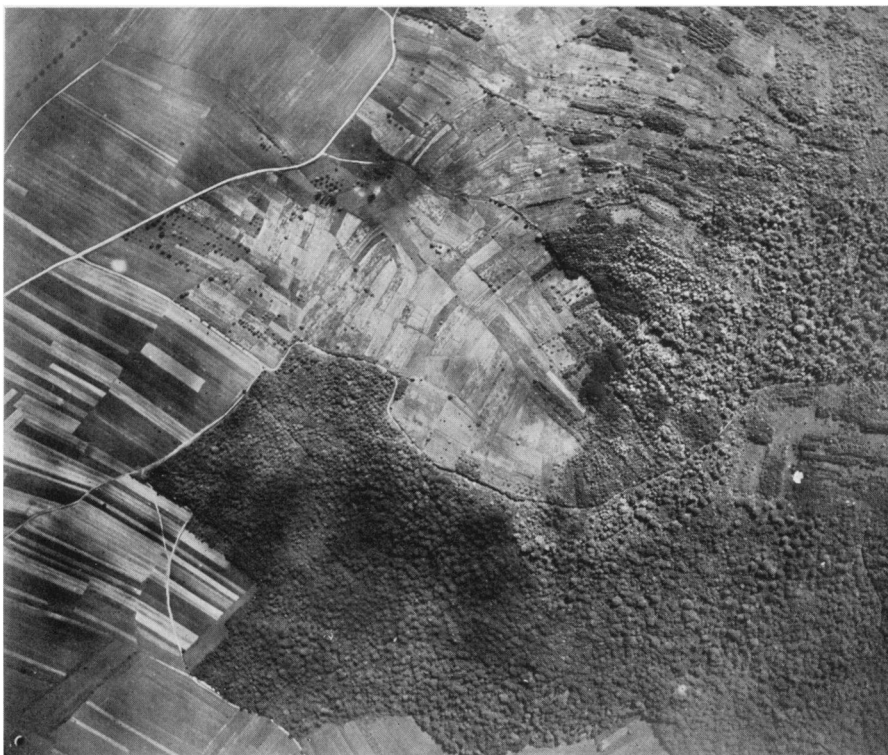


FIG. 6—Photograph from an airplane of an area in northeastern France from an altitude of 8,500 feet. Aërial photography is the most important adjunct of exploration by aircraft.

of ballast. At 3.35 we reached the height of 10,081 meters. Besides the equipment we only had on board three bags of ballast. We passed our time in making observations. Mr. Senouique tried his strength on the dynamometer. On earth it was 105; it now passed 110. That of Mr. Bienaimé, which was 140 on earth, was now 155. This indicated a similar increase in proportion. The ultra-violet rays were found to be more numerous here, and their intensity was remarkable. . . . We began to descend at 3.40; we were at 8,000 meters at 4.14; our speed of descent was, therefore, 166 meters per minute. There the bag took a fusiform shape and our parachute, which had been stiff until now, began to flap. At 3,000 meters we finally took off our oxygen masks, which we had lifted on several occasions during the ascension, so as to make note of physiological phenomena. I want here to express my admiration for the courage and devotion to science of our eminent friend, Mr. Senouique, for the very convincing experiments which he made at the greatest altitudes. We conducted these under most trying con-

ditions: at 10,000 meters, when one's heart is beating at a rate of 110 pulsations per minute, producing in the arteries and in the veins a pressure equal to a column of about 25 centimeters of mercury; when the exterior pressure was 210 millimeters, and the interior pressure 250 millimeters—which produces in the tissue of the circulation system a tension powerful enough to cause death.

Mr. Alan R. Hawley, President of the Aero Club of America, and Mr. Augustus Post in their many balloon ascensions have reached heights of over 25,000 feet. In one of the National Balloon Races they rose to a height of 25,000 feet; during the St. Louis-to-Canada trip they remained for about six hours at a height of some 15,000 feet. Breathing was a little hard, but they felt no ill effects afterward.

The physiology of high-altitude flying is an interesting and important subject; with the increasing need of knowledge in regard to it, it is hoped that reliable data will be collected on which definite conclusions can be based.

LANDING AIRPLANES ON THE HIMALAYA

Landing airplanes on such surfaces as the Himalaya may be expected to present, and starting again, will be mainly a matter of skill and organization. A specially made airplane for flying at high altitudes may not have a speed of more than 75 or 80 miles an hour and would have a very low landing speed. It would also be a very light machine and, if possessing a margin of power, could rise from a flat clearance of from 400 to 500 feet. In preliminary flights the aviator could drop tents, bags of food and equipment, and spare parts on a selected spot near the place where he intended to land. Dropping these things from an airplane would not be difficult. It was done repeatedly by the British aviators at Kut. Italian aviators also dropped bread and provisions on the mountains for their forces which had been cut off from their lines of communication and had exhausted their supplies. The aviators carried sufficient food and provisions to last them many days.

Having carried and dropped all the equipment necessary, the aviator could then attempt the landing. It would be well for him to carry a passenger in order to have some one ready to assist him in case he found it necessary to make repairs, or ready to arrange for the return trip on foot in case he found it impossible to start again.

It is hardly necessary to go further in speculating regarding the possibilities of landing on and starting from the Himalaya. Wherever there is a clearing of from 500 to 1,000 feet, there an airplane can land and from thence it can start. Instances of suitable locations are given by Dr. Kellas.⁷

The challenging barrier of the Himalaya will succumb to the airman. Mt. Everest and Mt. Kangchenjhou will stand as milestones in the history of man's conquest of the air and as landmarks to the airmen who will link British India with other civilized centers.

⁷ Article cited in footnote 1, p. 379.